NAVSHIPS 0969-028-4020

VOLUME 2

OPERATORS' MANUAL

for

DIGITAL READOUT ELECTRONIC COUNTER AN/USM-207

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

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SECTION 3

OPERATION

3-1. FUNCTIONAL OPERATION.

Digital Readout Electronic Counter AN/USM-207 is a portable electronic counter providing direct-reading indication of frequency and period of a cyclic electrical signal, the frequency ratio between two signals, and the time interval between two points on two signals or on the same signal, and the total number of electrical impulses. The counter also provides various standard frequency outputs and signals having frequencies equal to an input frequency divided (or scaled) by known factors.

The counter consists primarily of circuits which generate accurate timing signals of various durations, a series of electronic counting units, a gate for controlling the counting time, and frequency multiplying circuits and mixer for heterodyne frequency measurement. The controlling signals for the gate, timing, and counting circuits can be derived from various external sources, and the circuits are interconnected in various ways to permit the instrument to make a wide variety of time, frequency, and ratio measurements.

The counter also contains amplifiers to increase the magnitude and to shape the incoming count and control signals, an oscillator and multiplier to generate the timing signals, a chain of dividers to permit variations in count and control signal rates, display circuits for controlling the readout indications, and necessary power supplies.

3-2. PREPARATION FOR USE.

Before attempting to operate the counter, familiarize yourself with the function of all the front and rear panel controls and connectors, as referenced in paragraph 3-3, read the operating precautions given in paragraph 3-4, and the operating suggestions in paragraph 3-5. Then refer to table 3-3 for the initial turn-on and operating procedure.

3-3. DESCRIPTION OF CONTROLS, CONNECTORS, AND INDICATORS.

The controls, connectors, and indicator of the counter which are normally used by the operator are shown in figures 3-1 and 3-2 and are described in table 3-2. The numbers on the figure relate each item to the descriptive text in table 3-2 and do not indicate a preferred order of operation.

3-4. OPERATING PRECAUTIONS.

To prevent damage when connecting signals to the BNC connectors on the counter be sure that the amplitudes of the voltages do not exceed the values listed in the last column of table 3-1. To obtain rated accuracy listed in paragraph 1-2, the minimum input voltage must be as specified in that table.

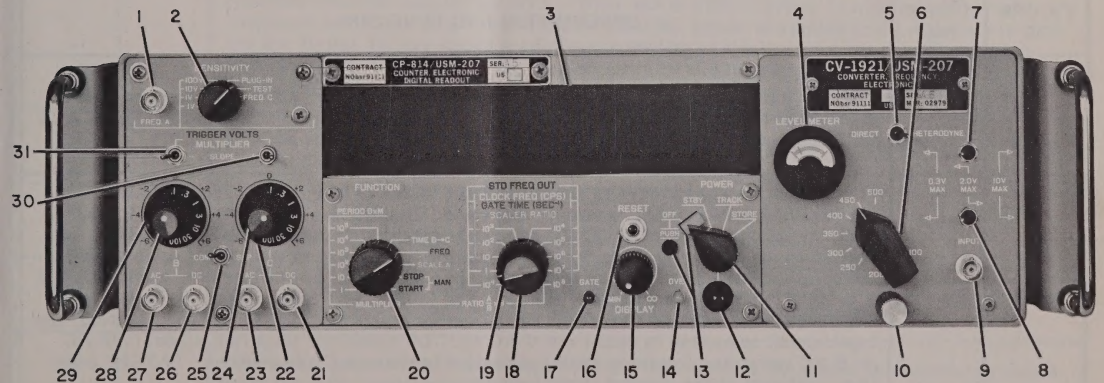

Figure 3-1. Counter Front Panel Controls, Connectors, and Indicators

TABLE 3-1. VOLTAGE INPUTS

CONNECTOR	FIGURE NO.	INDEX NO.	MINIMUM INPUT	MAXIMUM SAFE VOLTAGE
FREQ. A	3-1	1	0.1 volt rms	a. ±600 volts peak. b. 300 volts rms from 1.0 cps to 10 mc, except 150 volts rms when SENSITIVITY switch is set to the .1 position. c. 100 volts rms from 10 mc to 100 mc.
B, AC and C, AC	3-1	27 23	0.1 volt rms	a. ±600 volts peak. b. 425 volts rms, except 150 volts rms when MULTIPLIER switch is set to the .1 position.
B, DC and C, DC	3-1	26 21	0.1 volt rms	±600 volts peak, except ±210 volts peak when MULTIPLIER switch is set to the .1 position.
			Note When mode selector switch is set to COM, whichever position of the B or C MULTIPLIER switches is lower determines the maximum allowable voltage applied to either of the B connectors; i.e., if B MULTIPLIER switch is set to 1 and C MULTIPLIER switch is set to .1 the maximum allowable input to the B, AC connector is 150 volts rms and to the B, DC connector is 210 volts peak.	
Converter INPUT	3-1	9	0.01 volt rms	a. ±600 volts peak. b. 10 volts rms with both attenuator switches set to the right; 2 volts rms with one attenuator set to the right and one set to the left; 0.3 volt rms with both attenuator switches set to the left.
100 KC OR 1 MC INPUT	3-2	4	0.5 volt rms	a. ±600 volts peak. b. 10 volts rms.

TABLE 3-2. DESCRIPTION OF OPERATING CONTROLS, CONNECTORS, AND INDICATORS

FIGURE NO.	INDEX NO.	DESCRIPTION AND FUNCTION
3-1	1	FREQ.A input connector. Accepts an external signal for frequency and frequency-ratio measurements, for totalizing, and for obtaining scaled outputs at STD FREQ OR SCALE OUT connector when FUNCTION switch is set to SCALE A.
3-1	2	SENSITIVITY switch. Selects source of input signal in frequency, frequency ratio (numerator) and totalizing modes of operation. In positions .1 V through 100 V, the input signal connected to the FREQ.A input connector is attenuated in decade steps, and applied to the channel A. Maximum attenuation is obtained in the 100 V position; minimum rms voltage that triggers the counter is equal to the switch-position marking (.1 V, 1 V, 10 V, 100 V). In PLUG-IN position, the input signal connected to the converter INPUT connector is routed through the converter to channel A. In FREQ.C position, the input signal connected to either the C AC or C DC connector (separate mode) or B DC or B AC connector (common mode) is applied to channel C and counted. In TEST position, self-test of the counter is performed.

TABLE 3-2. (Continued)

FIGURE NO.	INDEX NO.	DESCRIPTION AND FUNCTION
3-1	3	Digital display. Indicates numerical results of measurement with automatically positioned decimal point, and includes an annunicator that indicates units of measurement (μS, MS, SEC, MC, and KC).
3-1	4	LEVEL METER. Indicates in green area when level of signal applied to the converter INPUT connector is sufficient to provide a valid digital readout. Indicates in red area when input signal level is questionable, is incorrectly attenuated by settings of attenuator switches, or if mixing frequency selector switch is set to a position that provides an invalid digital readout.
3-1	5	DIRECT-HETERODYNE switch. Selects routing of signal connected to the converter INPUT connector. When set to DIRECT, signal is measured directly, and the sensitivity of the counter for signals between 35 mc and 100 mc is increased to 0.01 volt. When set to HETERODYNE, signal is mixed with frequency selected by the mixing frequency selector switch.
3-1	6	Mixing frequency selector switch. Selects mixing frequency of 100, 150, 200, 250, 300, 350, 400, 450 or 500 mc in electronic frequency converter for heterodyne frequency measurement. Operates with LEVEL METER.
3-1	7 and 8	Converter attenuator switches. When both switches are set to the left, signal input to converter INPUT connector for heterodyne frequency measurement should not exceed 0.3 volt rms. When upper switch is set to left and lower switch is set to the right, the signal input should not exceed 2 volts rms. When both switches are set to the right, signal input should not exceed 10 volts rms. Maximum attenuation occurs when switches are both set to right; minimum attenuation occurs when both switches are set to the left.
3-1	9	Converter INPUT connector. Accepts an external signal (85 mc to 500 mc) for heterodyne frequency measurement, or an external signal of 35 mc to 100 mc for direct frequency measurement, for frequency ratio measurement, for totalizing, and for scaling. To measure the input signal applied to this connector, SENSITIVITY switch must be set to PLUG-IN.
3-1	10	Thumbscrew. Fastens electronic frequency converter to counter.
3-1	11	POWER switch. When set to OFF by first depressing the PUSH button, all power is removed from the counter circuits. When set to STBY, power is applied to the radio frequency oscillator only. When set to TRACK, power is applied to all counter circuits and the digital display shows a continuous display of the changing count. When set to STORE, power is applied to all counter circuits and the digital display remains constant during the count and changes only when the final count changes after any gate period.
3-1	12	POWER lamp (red). Indicates application of 115-volt ac power to counter when POWER switch is set to STBY, TRACK, or STORE.
3-1	13	PUSH button and bar. When button is depressed, POWER switch can be set to OFF. The bar ensures that power is not unintentionally removed.
3-1	14	OVEN lamp (yellow). Indicates that crystal oven heater in radio frequency oscillator is energized when POWER switch is set to STBY, TRACK, or STORE.
3-1	15	DISPLAY control. Increases length of time that count is displayed as control is rotated from the MIN. position clockwise. The measurement automatically recycles after the

TABLE 3-2. (Continued)

<table>
<tr><th>FIGURE NO.</th><th>INDEX NO.</th><th>DESCRIPTION AND FUNCTION</th></tr>
<tr><td>3-1</td><td>15 (cont)</td><td>display time. When switched to the extreme clockwise ∞ position, the count is displayed until RESET switch is pushed. The DISPLAY control is not effective in totalizing operation.</td></tr>
<tr><td>3-1</td><td>16</td><td>RESET switch. Permits manual reset of count to zero and start of a new count.</td></tr>
<tr><td>3-1</td><td>17</td><td>GATE lamp (green). Lights when count gate is open and electrical impulses can be counted.</td></tr>
<tr><td>3-1</td><td>18</td><td>STD FREQ OUT switch (red). Selects standard frequency output (10^{-1}, 1, 10, 10^2, 10^3, 10^4, 10^5, 10^6, and 10^7 cps) that appears at STD FREQ OR SCALE OUT connector when FUNCTION switch is set to TIME B⟶C, FREQ, MAN STOP, or MAN START.</td></tr>
<tr><td>3-1</td><td>19</td><td>Time base switch (black).
a. Selects CLOCK FREQ (1, 10, 10^2, 10^3, 10^4, 10^5, 10^6, and 10^7 cps) that is counted in period and time-interval measurement; 10^{-1} and 10^8 switch positions are not used.
b. Selects GATE TIME for frequency measurements; the reciprocal of the number listed on the switch scale is the gate time in seconds that is selected as follows:
<table>
<tr><th>SWITCH POSITION (SEC^{-1} SCALE)</th><th>GATE TIME</th></tr>
<tr><td>10^{-1}</td><td>10 seconds</td></tr>
<tr><td>1</td><td>1 second</td></tr>
<tr><td>10</td><td>100 milliseconds</td></tr>
<tr><td>10^2</td><td>10 miiliseconds</td></tr>
<tr><td>10^3</td><td>1 millisecond</td></tr>
<tr><td>10^4</td><td>100 microseconds</td></tr>
<tr><td>10^5</td><td>10 microseconds</td></tr>
<tr><td>10^6</td><td>1 microsecond</td></tr>
<tr><td>10^7 and 10^8</td><td>Not used</td></tr>
</table>
c. Selects SCALER RATIO of 10, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7 and 10^8 by which frequency of signal applied to FREQ.A input connector is divided when FUNCTION switch is set to SCALE A. (10^{-1} and 1 positions are not used.) Scaled signal is available at STD FREQ OR SCALE OUT connector.
d. Selects frequency ratio measurement when set to the 10^8 position and with the FUNCTION switch set to 1, 10, 10^2, 10^3, 10^4 and 10^5.
The time base switch in conjunction with the FUNCTION switch position selects the unit of measurement and decimal point that are displayed in frequency, period, and time-interval measurements.</td></tr>
<tr><td>3-1</td><td>20</td><td>FUNCTION switch. Selects measurement or scaling mode of operation in conjunction with positions of SENSITIVITY switch and time base switch as follows:
<table>
<tr><th>FUNCTION SWITCH POSITION</th><th>TIME BASE SWITCH POSITION</th><th>SENSITIVITY SWITCH POSITION</th><th>MEASUREMENT OR SCALING MODE</th></tr>
<tr><td>PERIOD
B x M</td><td>CLOCK FREQ (CPS)</td><td>---</td><td>Period of input B signal.</td></tr>
<tr><td>10^5</td><td>10^4 thru 10^7</td><td></td><td></td></tr>
<tr><td>10^4</td><td>10^3 thru 10^7</td><td></td><td></td></tr>
<tr><td>10^3</td><td>10^2 thru 10^7</td><td></td><td></td></tr>
</table></td></tr>
</table>

TABLE 3-2. (Continued)

FIGURE NO.	INDEX NO.	DESCRIPTION AND FUNCTION			
		FUNCTION SWITCH POSITION	TIME BASE SWITCH POSITION	SENSITIVITY SWITCH POSITION	MEASUREMENT OR SCALING MODE
3-1	20 (cont)	PERIOD B x M 10^2 10 1	CLOCK FREQ (CPS) 10 thru 10^7 1 thru 10^7 1 thru 10^7	---	Period of input B signal.
		PERIOD B x M 10^5, 10^4, 10^3, 10^2, 10, 1	RATIO $\frac{A}{B}$ x M (10^8 position)	100 V, 10 V, 1 V, or .1 V	Ratio of signal A frequency to signal B frequency.
				PLUG-IN	Ratio of converter input signal frequency to signal B frequency.
				FREQ. C	Ratio of signal C frequency to signal B frequency.
		TIME B➡C	CLOCK FREQ (CPS) 1 thru 10^7	---	Time interval from input B to input C.
			10^8	100 V, 10 V, 1 V, or .1 V	Number of input A pulses between B and C inputs (time interval with external clock).
		SCALE A	SCALER RATIO 10 thru 10^8	↓	Scale signal A frequency.
				PLUG-IN	Scale converter input-signal frequency.
				FREQ. C ↓	Scale signal C frequency.
		MAN START MAN STOP	---		Start and stop signal C totalizing.
				100 V, 10 V, 1 V, or .1 V	Start and stop signal A totalizing.
				PLUG-IN	Start and stop converter input-signal totalizing.
		FREQ	GATE TIME (SEC^{-1}) 10^{-1} thru 10^6	100 V, 10 V, 1 V, or .1 V	Frequency of input A signal.
				TEST	Self-test; measures 10-mc test signal.

TABLE 3-2. (Continued)

<table>
<tr><th>FIGURE NO.</th><th>INDEX NO.</th><th colspan="4">DESCRIPTION AND FUNCTION</th></tr>
<tr><td rowspan="3">3-1</td><td rowspan="3">20 (cont)</td><td>FUNCTION SWITCH POSITION</td><td>TIME BASE SWITCH POSITION</td><td>SENSITIVITY SWITCH POSITION</td><td>MEASUREMENT OR SCALING MODE</td></tr>
<tr><td rowspan="2">FREQ</td><td rowspan="2">GATE TIME (SEC^{-1})
10^{-1} thru 10^{6}</td><td>PLUG-IN</td><td>Frequency measurement of signal applied to converter INPUT connector.</td></tr>
<tr><td>FREQ.C</td><td>Frequency measurement of signal applied to input B or C connector.</td></tr>
<tr><td>3-1</td><td>21</td><td colspan="4">Channel C DC connector. Accepts an external signal for frequency measurement, frequency-ratio measurement, totalizing, or scaling. When the mode selector switch is set to SEP, the signal applied to this receptacle is coupled directly to channel C. For pulsating dc signals the dc level is added to the ac level to provide the exact triggering point; i.e., if the ac signal is riding on a 3-volt dc level, then subtract 3 volts from the product of the settings of the C TRIGGER VOLTS control and C MULTIPLIER switch to determine the ac component of the input C trigger level.</td></tr>
<tr><td>3-1</td><td>22</td><td colspan="4">Channel C MULTIPLIER switch (black): Selects multiplier for setting of channel C TRIGGER VOLTS control. Switch position is the number (.1, .3, 1, 3, 10, 30, 100) which is under the number "0" of the scale of the channel C TRIGGER VOLTS control. Maximum signal attenuation is obtained with the MULTIPLIER switch set to 100; this position should be used first when the C (or B if mode selector switch is set to COM) input signal is of an unknown amplitude. To determine the exact amplitude that will trigger channel C, multiply the setting of the C TRIGGER VOLTS control by the setting of the C MULTIPLIER switch.

In operation with a sine-wave input, the MULTIPLIER switch is set as follows:

<table>
<tr><th>INPUT VOLTS (RMS)</th><th>SWITCH SETTING</th><th>INPUT VOLTS (RMS)</th><th>SWITCH SETTING</th></tr>
<tr><td>0.1 to 0.3</td><td>.1</td><td>10 to 30</td><td>10</td></tr>
<tr><td>0.3 to 1</td><td>.3</td><td>30 to 100</td><td>30</td></tr>
<tr><td>1 to 3</td><td>1</td><td>100 to 425</td><td>100</td></tr>
<tr><td>3 to 10</td><td>3</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>3-1</td><td>23</td><td colspan="4">Channel C AC connector. Accepts an external signal for frequency measurement, frequency-ratio measurement, totalizing, or for scaling. When the mode selector switch is set to SEP, the signal applied to this connector is capacity coupled to channel C.</td></tr>
<tr><td>3-1</td><td>24</td><td colspan="4">Channel C TRIGGER VOLTS control (red). Selects any voltage from +6 volts to -6 volts which when multiplied by the setting of C MULTIPLIER switch determines the exact triggering point of the channel C input signal. When the control is set to zero, the triggering point is the zero voltage point.</td></tr>
<tr><td>3-1</td><td>25</td><td colspan="4">Mode selector switch. In SEP (separate) position, connects input C signal to channel C. In COM (common) position, connects input B signal to channel C.</td></tr>
<tr><td>3-1</td><td>26</td><td colspan="4">Channel B DC connector. Accepts an external signal for period, frequency-ratio, and time-interval measurements. In frequency-ratio measurement, the frequency of the signal serves as the denominator; in time-interval measurement, the signal serves as the start signal and when the mode selector switch is set to COM, also serves as the</td></tr>
</table>

TABLE 3-2. (Continued)

<table>
<tr><th>FIGURE NO.</th><th>INDEX NO.</th><th>DESCRIPTION AND FUNCTION</th></tr>
<tr><td>3-1</td><td>26 (cont)</td><td>stop signal. Provides direct coupling to all signals. When connected to pulsating dc signals, the dc level is added to the ac level to provide the exact triggering point; i.e., if the ac signal is riding on a 3-volt dc level, then subtract 3 volts from the product of the B TRIGGER VOLTS and B MULTIPLIER settings to determine the ac component of the trigger level.</td></tr>
<tr><td>3-1</td><td>27</td><td>Channel B AC connector. Accepts an external signal for period, frequency-ratio, and time-interval measurements. In frequency-ratio measurement, the frequency of the signal serves as the denominator; in time-interval measurement, the signal serves as the start signal and when the mode selector switch is set to COM, also serves as the stop signal. This connector provides capacitive coupling.</td></tr>
<tr><td>3-1</td><td>28</td><td>Channel B TRIGGER VOLTS control (red). Selects any voltage point from +6 volts to -6 volts which when multiplied by the setting of the channel B MULTIPLIER control determines the exact triggering point of the channel B input signal. When set to zero, the triggering point will be the zero voltage point.</td></tr>
<tr><td>3-1</td><td>29</td><td>Channel B MULTIPLIER switch (black). Selects attenuation factor for channel B input signal. Switch position is selected by rotating the switch to the number (.1, .3, 1, 3, 10, 30, 100) which is under the number "0" of the scale of the channel B TRIGGER VOLTS control. Maximum signal attenuation is obtained with the MULTIPLIER switch set to 100; this position should be used first for unknown-amplitude signals. The switch position number is the minimum rms amplitude of the signal applied to the channel B input connector that will trigger the counter. The MULTIPLIER switch position is multiplied by the setting of the channel B TRIGGER VOLTS control to determine the exact voltage amplitude of the input B signal that will trigger the counter. In operation, the MULTIPLIER switch is normally set as follows:
<table>
<tr><th>INPUT VOLTS (RMS)</th><th>SWITCH SETTING</th><th>INPUT VOLTS (RMS)</th><th>SWITCH SETTING</th></tr>
<tr><td>0.1 to 0.3</td><td>.1</td><td>10 to 30</td><td>10</td></tr>
<tr><td>0.3 to 1</td><td>.3</td><td>30 to 100</td><td>30</td></tr>
<tr><td>1 to 3</td><td>1</td><td>100 to 425</td><td>100</td></tr>
<tr><td>3 to 10</td><td>3</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>3-1</td><td>30</td><td>Channel C SLOPE switch. Selects either positive (+) or negative (-) slope of input B or C signal for triggering of channel C. Signal B is connected when the mode selector switch is set to the COM position, and signal C is selected when that switch is set to the SEP position.</td></tr>
<tr><td>3-1</td><td>31</td><td>Channel B SLOPE switch. Selects either positive (+) or negative (-) slope of channel B input signal for triggering of counter to provide start and stop signals in period and frequency-ratio measurements and to provide start signals in time-interval (TIME B→C) measurement.</td></tr>
<tr><td>3-2</td><td>1</td><td>1 MC OUT connector. Supplies 1-mc signal to external equipment when POWER switch is set to STANDBY, TRACK, or STORE.</td></tr>
<tr><td>3-2</td><td>2</td><td>PRINTER connector. Supplies signals representing the digital data output of the measurement including the decimal-point position in four-line binary-coded decimal form. Included in the output are control signals for the operation of printers, other data recorders, or control devices, and a reset inhibit line to prevent reset of the counter during data recording (see table 2-1).</td></tr>
</table>

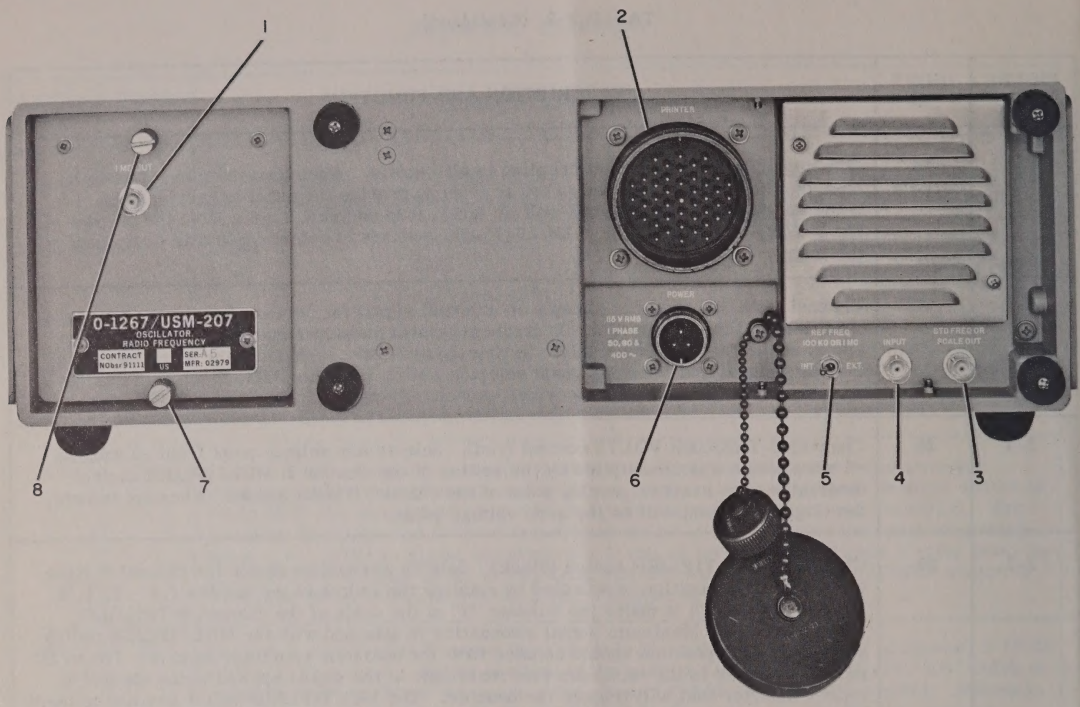

Figure 3-2. Counter Rear Panel Controls and Connectors

TABLE 3-2. (Continued)

FIGURE NO.	INDEX NO.	DESCRIPTION AND FUNCTION
3-2	3	STD FREQ OR SCALE OUT connector. a. Supplies 0.1 cps, 1 cps, 10 cps, 100 cps, 1 kc, 10 kc, 100 kc, 1 mc, and 10 mc as set by STD FREQ OUT switch when FUNCTION switch is set to TIME B→C, MAN START, MAN STOP, or PERIOD BxM-1. b. Supplies scaled frequencies of the signal applied to either the FREQ.A input connector, C AC input connector, C DC input connector, or converter INPUT connector, as selected by the SENSITIVITY switch. Scale factor is selected by the time base switch, and ranges from 10 to 10^8 in decade steps.
3-2	4	Time base INPUT connector. Accepts 100-kc or 1-mc as time-base signal for counter when REF FREQ 100 KC OR 1 MC switch is set to EXT.
3-2	5	REF FREQ 100 KC OR 1 MC switch. When set to INT, the 1-mc oscillator in the internal radio frequency oscillator serves as the standard time base frequency for the counter. When set to EXT, a 100-kc or 1-mc signal applied to the time base INPUT connector serves as the standard frequency.
3-2	6	POWER connector. Connects to ac power cable.
3-2	7, 8	Thumbscrews. Fasten radio frequency oscillator to counter.

3-5. OPERATING SUGGESTIONS FOR MEASURING FREQUENCY, FREQUENCY RATIO, FOR TOTALIZING, AND SCALING.

These measurements can be performed by following one of three procedures. In the first set of procedures (tables 3-5, 3-9, 3-14, and 3-20) the input signal (numerator signal when frequency ratio is measured) is connected to the FREQ·A input connector and switched to channel A. In the second procedure (tables 3-6, 3-10, 3-15, and 3-21) the input signal is connected to the input C connector and switched to channel C. In the third procedure (tables 3-7, 3-11, 3-16, 3-17, 3-18, and 3-22) input signal is connected to the converter INPUT connector and switched through the converter to channel A. The choice as to which procedure to follow depends on input signal characteristics such as repetition rate, pulse shape, and amplitude. The capabilities of the counter can best be utilized as follows:

a. INPUT SIGNAL FREQUENCY BELOW 10 CPS. — Connect input signal to the C DC input connector and follow the instructions in table 3-6, 3-10, or 3-15.

b. INPUT SIGNAL FREQUENCY BETWEEN 10 CPS AND 1 MC. — When the input pulses are symmetrical, connect input signal to the FREQ·A input connector, and follow the instructions in table 3-5, 3-9 or 3-14. When the input pulses are not symmetrical, connect input signal to the applicable input C connector, and follow the instructions in table 3-6, 3-10, or 3-15.

c. INPUT SIGNAL BETWEEN 1 MC AND 35 MC. — Connect the input signal to the FREQ·A input connector, and follow the instructions in table 3-5, 3-9, or 3-14.

d. INPUT SIGNAL BETWEEN 35 MC AND 100 MC. — When the input signal amplitude is between 10 millivolts and 100 millivolts, connect input signal to the converter INPUT connector, and follow the instructions in table 3-7, 3-11, or 3-16. When the input signal amplitude is 100 millivolts or greater, connect input signal to the FREQ·A input connector, and follow the instructions in table 3-5, 3-9, or 3-14.

e. INPUT SIGNAL BETWEEN 85 MC AND 500 MC (FREQUENCY MEASUREMENT ONLY). — Input signals in this frequency range are applied to the converter INPUT connector and measured by the use of the heterodyne principle; i.e., the unknown input signal frequency is beat with a known mixing frequency, and the resultant difference frequency is measured. The procedure for heterodyne frequency measurement is given in tables 3-17 and 3-18. In addition to the desired difference frequency, heterodyning produces other, undesired frequencies. In some instances an undesired frequency may attain amplitudes sufficient to be registered by the counter, producing a seemingly valid readout. Unless the approximate input frequency is known, the validity of all readouts obtained by the heterodyne method must be tested.

Signal levels which are indicated in the red zone of the LEVEL METER may possibly be of a sufficient amplitude for a valid measurement. Such signals usually produce consistent readouts in position 100 or in two or three positions of the mixing frequency selector switch. Before rejecting a readout produced by a signal which indicates in the red zone, test its validity.

The validity of any readout is tested by complementing; i.e., two measurements are performed on the same input frequency and the relationship between the two readouts is noted. In one measurement, a mixing frequency is selected which is from 5 mc to 60 mc below the frequency of the input signal. In the other measurement a mixing frequency is selected which is from 5 mc to 60 mc above the frequency of the input signal. The readouts of the two measurements are added and compared with the two mixing frequencies. If the sum of the two readouts is equal to the difference between the two mixing frequencies, the measurement is valid. The available mixing frequencies range from 100 mc to 500 mc in 50-mc increments, and are selected by the mixing frequency selector switch. Depending on the input frequency, complement tests are performed one of two ways. Examples and procedures for complement tests are as follows:

(1) Consistent readouts are obtained in three adjacent positions of the mixing frequency selector switch or in two positions which are 100 mc apart. Record the number displayed at the highest and lowest of the switch positions and add the two numbers. If the sum is equal to 100 mc, it is a valid measurement. The unknown frequency is the readout obtained in the lowest of the switch positions plus that switch position in mc.

For example, assume that the lowest switch position is 200, and the readout in that position is 57.8 mc. Also assume that the highest switch position is 300, and the readout in that position is 42.2 mc. The sum of 57.8 and 42.2 is 100, and the unknown frequency is 57.8 mc plus 200 mc or 257.8 mc.

(2) Consistent readouts are obtained only in the 100 position of the mixing frequency selector switch. Record the readout in that position, then set the DIRECT/HETERODYNE switch to DIRECT, record the new readout, and add it to the first readout. If the sum is equal to 100 mc, it is a valid measurement, and the unknown frequency is that obtained in the DIRECT position.

3-6. TEST APPLICATIONS.

Examples of applications of the counter are as follows:

a. FREQUENCY MEASUREMENT. — Applications are included in NAVSHIPS 900,000.103, Electronics Installation and Maintenance Book Test Methods and Practices.

b. PERIOD AND MULTIPLE PERIOD MEASUREMENT. — Low-frequency input signals can be measured with a high degree of accuracy. In frequency measurement, the inherent inaccuracy due to gating error is ±1 count. Expressed as a percentage, this ±1 count ambiguity may become an appreciable error. For example, when the frequency of a 10-cps input signal is measured with a 10-second gate time (longest gate time available in the instrument), the inherent inaccuracy due to gating error is ±1 percent. Measuring the period of the same 10-cps input signal, the inherent inaccuracy due to gating error can be reduced to ±0.0001 percent by selecting a 10-mc

clock frequency. When measuring multiple period, this error can be further reduced by factors of 10, 100, 1,000, 10,000, and 100,000. As a general rule, the dividing line between frequency measurement and period measurement is 1 kc; measure frequency when the input signal is above 1 kc, and measure period when the input signal is below 1 kc.

c. FREQUENCY-RATIO MEASUREMENT. — The counter can test and calibrate frequency multipliers and frequency dividers. For example, when calibrating a frequency multiplier with a known multiplying factor, the input and output frequencies of the multiplier are applied to the counter, and their ratio is measured. The frequency multiplier is then adjusted for the proper readout.

d. TIME INTERVAL MEASUREMENT. — To measure relay delay time, the coil-energizing voltage triggers the start channel; and a set of normally closed contacts, through a voltage source, triggers the stop channel. Delay time can be measured with a maximum resolution of 100 nanoseconds.

e. TIME INTERVAL MEASUREMENT WITH AN EXTERNAL STANDARD. — This measurement applies when calibrating search radar equipment. Transmissions are made at a target placed at a known distance from the radar equipment. A clock frequency of approximately 16.4 mc is connected to channel A of the counter. The transmitted pulse triggers the start channel of the counter, and the received echo triggers the stop channel. Distance is read in 100-yard increments.

f. TOTALIZING. — All types of non-periodic pulses, such as those generated by a nuclear particle detector, can be counted.

g. SCALING THE STANDARD FREQUENCY. — The scaled frequencies can be supplied to instruments and systems requiring precise time standard.

h. SCALING THE INPUT FREQUENCY. — The low-frequency output signals can supplement the output of a vhf signal generator. For example, when the available signal generator covers the frequency range from 10 mc to 100 mc, its output is applied to channel A of the counter. Then, by use of the scale function, the frequency range is extended to cover any frequency from 1 cps to 100 mc.

3-7. OPERATING PROCEDURES.

Procedures for turning on the counter, testing counter performance, performing the measurement functions, and obtaining the signal outputs are given in tables 3-3 through 3-24. Perform the procedure of table 3-3 prior to any of the other procedures in those tables.

All measurement and signal-output functions can be performed with the frequency converter and radio frequency oscillator installed.

All functions except heterodyne frequency measurement, and direct frequency measurement to 100 mc can be performed with the frequency converter removed.

Totalizing and frequency-ratio measurements can be performed with the radio frequency oscillator removed.

All functions except use of the 1 MC OUT connector can be performed when an external reference frequency standard is connected as described in paragraph 3-8.

3-8. CONNECTION OF FREQUENCY STANDARD.

When the radio frequency oscillator is to be the reference frequency standard, set REF FREQ 100 KC OR 1 MC switch on rear panel to INT.

To connect an external 1 mc or 100 kc signal as the frequency standard, first set REF FREQ 100 KC OR 1 MC switch on the rear panel to EXT. Then, connect the 1 mc or 100 kc signal to the time base INPUT connector on the rear panel.

TABLE 3-3. PROCEDURE FOR TURNING ON COUNTER

STEP	ACTION
1	Set POWER switch to STBY, and observe that POWER lamp is lit, and that OVEN lamp is lit (when radio frequency oscillator is installed).
2	Allow at least five minutes for warm-up, except no warm-up time is required for totalizing, frequency-ratio measurement, or with an external reference frequency standard.
3	Set POWER switch to TRACK. Numeral should be displayed on all eight digits of the display.

TABLE 3-4. PROCEDURE FOR SELF TEST

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to TEST.
3	Set time base switch to 10^6 (CPS).
4	Rotate DISPLAY control to MIN, and set POWER switch to STORE.
5	Set FUNCTION switch to FREQ.
6	Rotate time base switch counterclockwise, one position at a time, and observe digital display. Displays should be as shown below, ±1 count.

TIME BASE SWITCH POSITION	DISPLAY
10^6	00000010. MC
10^5	0000010.0 MC
10^4	000010.00 MC
10^3	00010000. KC
10^2	0010000.0 KC
10	010000.00 KC
1	10000.000 KC
10^{-1}	0000.0000 KC

TABLE 3-5. PROCEDURE FOR FREQUENCY MEASUREMENT, WITH THE INPUT SIGNAL APPLIED TO CHANNEL A

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set DISPLAY control for desired display time.
3	Set SENSITIVITY switch to 100 V.
4	Set time base switch to GATE TIME $(SEC^{-1})-10^4$.
5	Set FUNCTION switch to FREQ.
6	Connect input signal to the FREQ.A input connector.
7	Press RESET switch and observe digital display. If display remains at zero or readout is erratic (evidence of weak input signal), turn SENSITIVITY switch counterclockwise to the first position at which consistent readouts are displayed.
8	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
9	Numerical display is the frequency of the input signal in kc with the decimal point position as indicated. To obtain a readout in mc, set time base switch to a more clockwise GATE TIME (SEC^{-1}) position. To obtain higher resolutions (up to 0. 1 cps) set time base switch to a more counterclockwise position.

TABLE 3-6. PROCEDURE FOR FREQUENCY MEASUREMENT, WITH THE INPUT SIGNAL APPLIED TO CHANNEL C

Note

Follow this procedure only when the input signal does not exceed 1 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set DISPLAY control for desired display time.
3	Set SENSITIVITY switch to FREQ.C.

TABLE 3-6. (Continued)

STEP	ACTION
4	Set time base switch to GATE TIME $(SEC^{-1})-10^4$.
5	Set FUNCTION switch to FREQ.
6	Set C MULTIPLIER switch to 100.
7	Set C TRIGGER VOLTS control to 0.
8	Connect input signal to the applicable input C connector.
9	Press RESET switch.
10	Turn C TRIGGER VOLTS control slowly in both directions, and, if necessary, change setting of C SLOPE switch, until consistent readouts are displayed. If display stays at zero or readout is erratic (evidence of weak input signal), turn C MULTIPLIER switch clockwise to the first position at which consistent readouts are displayed.
11	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
12	Numerical display is the frequency of the input signal in kc, with the decimal point position as indicated. To obtain a readout in mc, set time base switch to a more clockwise GATE TIME (SEC^{-1}) position. To obtain higher resolutions (up to 0. 1 cps) set time base switch to a more counterclockwise position.

TABLE 3-7. PROCEDURE FOR DIRECT FREQUENCY MEASUREMENT, WITH THE INPUT SIGNAL APPLIED TO THE CONVERTER INPUT CHANNEL

Note

Follow this procedure only when the input signal frequency falls between 35 mc and 100 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to PLUG-IN.
3	Set FUNCTION switch to FREQ.
4	Set time base switch to GATE TIME $(SEC^{-1})-10^6$.

TABLE 3-7. (Continued)

STEP	ACTION
5	Set DISPLAY control for desired display time.
6	Set both converter attenuator switches to the right (10 V MAX position).
7	Set DIRECT-HETERODYNE switch to DIRECT.
8	Connect input signal to the converter INPUT connector.
9	Observe LEVEL METER. If it reads in the green zone, proceed to step 12. Otherwise, proceed to step 10.
10	Set upper attenuator switch to the left (2.0 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 12. Otherwise, proceed to step 11.
11	Set lower attenuator switch to the left (0.3 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 12. If it does not read in the green zone, input level is too low for a valid measurement.
12	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
13	Observe digital display. Frequency is read directly in mc, with a resolution of 1 mc. To obtain readings with a higher resolution, set time base switch to a more counterclockwise position (up to 1).

TABLE 3-8. PROCEDURE FOR MEASURING PERIOD

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set FUNCTION switch to PERIOD B x M-1.
3	Set time base switch to CLOCK FREQ (CPS)-10^7.
4	Set DISPLAY control for desired display time.
5	Set B TRIGGER VOLTS control to 0.

TABLE 3-8. (Continued)

STEP	ACTION
6	Set B MULTIPLIER switch to 100.
7	Connect input signal to the applicable input B connector.
8	Turn B MULTIPLIER switch clockwise until GATE lamp cycles on and off. Adjust B TRIGGER VOLTS control until consistent readouts are displayed. To obtain this, it may be necessary to change the setting of the B SLOPE switch.
9	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
10	Numerical display is one period of the input signal in microseconds, with a resolution of 0.1 microsecond. To obtain a readout in milliseconds or seconds, or if overflow occurs, set time base switch to a more counterclockwise CLOCK FREQ (CPS) position.
11	For greater measurement accuracy, set the FUNCTION switch to a more clockwise position (up to 10^5), and measure the average of 10, 10^2, 10^3, 10^4, or 10^5 periods of the input signal. The accuracy of the period measurement increases in proportion to the period multiplier (M). Automatic decimal-point positioning compensates for the period multiplier, so that the numerical display always represents a single period.

TABLE 3-9. PROCEDURE FOR MEASURING FREQUENCY RATIO, WITH NUMERATOR SIGNAL APPLIED TO CHANNEL A

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set time base switch to (A/B) x M-10^8.
3	Set DISPLAY control for desired display time.
4	Set FUNCTION switch to MULTIPLIER-1.
5	Set SENSITIVITY switch to 100 V.
6	Set B TRIGGER VOLTS control to 0.

TABLE 3-9. (Continued)

STEP	ACTION
7	Set B MULTIPLIER switch to 100.
8	Connect input signal with the higher frequency to the FREQ.A input connector.
9	Connect input signal with the lower frequency to the applicable input B connector.
10	Observe GATE lamp. If it goes on and off in a continuous cycle, proceed to step 13. Otherwise, proceed to step 12.
11	Adjust B TRIGGER VOLTS control and/or set B MULTIPLIER switch to the first clockwise position at which the GATE lamp cycles on and off.
12	Press RESET switch and observe digital display. If display remains at zero, or if repeated readouts are not consistent, turn SENSITIVITY switch to the first counterclockwise position at which consistent readouts are displayed.
	Note An alternate method for adjusting the input A and B controls (steps 11 and 12) is to perform the procedures of tables 3-5 and 3-6 and then perform all steps of table 3-7 except steps 5 thru 12.
13	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
14	The numerical display is the ratio of input A signal frequency to the input B signal frequency, with a resolution of 0.1. To obtain higher resolution, turn FUNCTION switch to a more clockwise position (10, 10^2, 10^3, 10^4, or 10^5).

TABLE 3-10. PROCEDURE FOR MEASURING FREQUENCY RATIO, WITH NUMERATOR SIGNAL APPLIED TO CHANNEL C

Note

Follow this procedure only when the numerator signal does not exceed 1 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set time base switch to (A/B)x M–10^8.
3	Set DISPLAY control for desired display time.
4	Set FUNCTION switch to MULTIPLIER–1.
5	Set SENSITIVITY switch to FREQ. C.
6	Set B TRIGGER VOLTS control to 0.
7	Set B MULTIPLIER switch to 100.
8	Set C TRIGGER VOLTS control to 0.
9	Set C MULTIPLIER switch to 100.
10	Set mode selector switch to SEP.
11	Connect input signal with the higher frequency to the applicable input C connector.
12	Connect input signal with the lower frequency to the applicable input B connector.
13	Observe GATE lamp. If it goes on and off in a continuous cycle, proceed to step 15. Otherwise, proceed to step 14.
14	Turn B TRIGGER VOLTS control slowly in both directions, and, if necessary, change setting of B SLOPE switch, until GATE lamp goes on and off in a continuous cycle. If GATE lamp does not go on, or cycles erratically (evidence of weak input B signal), turn B MULTIPLIER switch clockwise to the first position at which the GATE lamp goes on and off in a continuous cycle.
15	Press RESET switch.
16	Turn C TRIGGER VOLTS control slowly in both directions, and, if necessary, change setting of C SLOPE switch until consistent readouts are displayed. If display stays at zero, or if readout is erratic (evidence of weak input C signal), turn C MULTIPLIER switch to the first position at which consistent readouts are displayed.
17	If display is desired to remain constant, except when measurement result changes, set POWER switch to STORE.
18	Numerical display is the ratio of the input C signal frequency to the input B signal frequency, with a resolution of 0.1. To obtain higher resolutions, turn FUNCTION switch to a more clockwise position (10, 10^2, 10^3, 10^4, or 10^5).

TABLE 3-11. PROCEDURE FOR MEASURING FREQUENCY RATIO, WITH NUMERATOR SIGNAL APPLIED TO THE CONVERTER CHANNEL

Note

Follow this procedure only when the numerator frequency falls between 35 mc and 100 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set time base switch to (A/B)x M–10^8.
3	Set DISPLAY control for desired display time.
4	Set FUNCTION switch to MULTIPLIER–1.
5	Set SENSITIVITY switch to PLUG-IN.
6	Set both converter attenuator switches to the right (10 V MAX position). Set DIRECT-HETERODYNE switch to DIRECT.
7	Set B MULTIPLIER switch to 100.
8	Set B TRIGGER VOLTS control to 0.
9	Connect input signal with the higher frequency to the converter INPUT connector.
10	Connect input signal with the lower frequency to the applicable input B connector.
11	Observe GATE lamp. If it goes on and off in a continuous cycle, proceed to step 13. Otherwise, proceed to step 12.
12	Turn B TRIGGER VOLTS control slowly in both directions, and, if necessary, change setting of B SLOPE switch, until GATE lamp goes on and off in a continuous cycle. If GATE lamp does not go on, or cycles erratically (evidence of weak input B signal), turn B MULTIPLIER switch clockwise to the first position at which GATE lamp goes on and off in a continuous cycle.
13	Observe LEVEL METER. If it reads in the green zone, proceed to step 16. Otherwise, proceed to step 14.
14	Set upper attenuator switch to the left (2.0 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 16. Otherwise, proceed to step 15.
15	Set lower attenuator switch to the left (0.3 V MAX position) and observe LEVEL METER. If it reads in the green zone,

TABLE 3-11. (Continued)

STEP	ACTION
15 (cont)	proceed to step 16. If it does not read in the green zone, input level is too low for a valid measurement.
16	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
17	Numerical display is the ratio of the input signal frequency connected to the converter INPUT connector to the frequency of input B signal, with a resolution of 0.1. To obtain higher resolution, turn FUNCTION switch to a more clockwise position (10, 10^2, 10^3, 10^4, or 10^5).

TABLE 3-12. PROCEDURE FOR MEASURING TIME INTERVAL

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set FUNCTION switch to TIME B➡C.
3	Set time base switch to CLOCK FREQ (CPS)–10^7.
4	Set DISPLAY control for desired display time.
5	Set B and C MULTIPLIER switches to 100.
6	If time interval is measured between two input signals: connect start input signal to the applicable B connector; stop input signal to the applicable C connector; and set mode selector switch to SEP. If time interval is measured between two points on the same waveform: connect input signal to the applicable B connector, and set mode selector switch to COM.
7	Set B SLOPE switch for the required waveform slope on which start trigger point is to be positioned.
8	Set B MULTIPLIER switch and B TRIGGER VOLTS control so that the product of their settings equals the amplitude and polarity at which start of time interval is to occur and so that the GATE lamp is illuminated.
9	Set C SLOPE switch for the required waveform slope on which stop trigger point is to be positioned.

TABLE 3-12. (Continued)

STEP	ACTION
10	Set C MULTIPLIER switch and C TRIGGER VOLTS control so that the product of their settings equals the amplitude and polarity at which end of time interval is to occur and so that the GATE lamp is periodically extinguished and consistent readouts are displayed. If readouts are inconsistent, perform steps 8 and 10 until consistent readouts are obtained at the voltage levels equal to the desired start and stop signals.
	Note
	Steps 8 and 10 are applicable when desired trigger points are known. If trigger points are unknown, initially set the B MULTIPLIER and C MULTIPLIER switches to the 100 positions. GATE lamp should cycle on and off. If not, adjust B MULTIPLIER switch and B TRIGGER VOLTS control until lamp lights and/or adjust C MULTIPLIER switch and C TRIGGER VOLTS control until lamp repeatedly goes off, and until repeated readouts are consistent. Determine the trigger points by the product of the MULTIPLIER and TRIGGER VOLTS settings.
11	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
12	Numerical display is the time interval in microseconds, with a resolution of 0.1 microsecond. To obtain a readout in milliseconds or seconds, or if overflow occurs, set time base switch to a more counterclockwise CLOCK FREQ (CPS) position (up to 1).

TABLE 3-13. PROCEDURE FOR MEASURING TIME INTERVAL, WITH EXTERNAL CLOCK

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set DISPLAY control for desired display time.
3	Set SENSITIVITY switch to 100 V.
4	Set time base switch to GATE TIME $(SEC^{-1})-10^4$.
5	Set FUNCTION switch to FREQ.

TABLE 3-13. (Continued)

STEP	ACTION
6	Connect external clock input signal to the FREQ. A input connector.
7	Press RESET switch and observe digital display. If display remains at zero or cycles erratically (evidence of weak input signal), turn SENSITIVITY switch counterclockwise to the first position at which consistent readouts are displayed.
8	Set FUNCTION switch to TIME B➡C.
9	Set time base switch to 10^8.
10	Set B and C MULTIPLIER switches to 100.
11	If time interval is measured between two input signals: connect start input signal to the applicable B connector; stop input signal to the applicable C connector; and set mode selector switch to SEP. If time interval is measured between two points on the same waveform: connect input signal to the applicable B connector, and set mode selector switch to COM.
12	Set B SLOPE switch for the required waveform slope on which start trigger point is to be positioned.
13	Set B MULTIPLIER switch and B TRIGGER VOLTS control so that the product of their settings equals the amplitude and polarity at which start of time interval is to occur and so that the GATE lamp is illuminated.
14	Set C SLOPE switch for the required waveform slope on which stop trigger point is to be positioned.
15	Set C MULTIPLIER switch and C TRIGGER VOLTS control so that the product of their settings equals the amplitude and polarity at which end of time interval is to occur and so that the GATE lamp is periodically extinguished and consistent readouts are displayed. If readouts are inconsistent, perform steps 13 and 15 until consistent readouts are obtained at the voltage levels equal to the desired start and stop signals.
	Note
	Steps 13 and 15 are applicable when desired trigger points are known. If trigger points are unknown, initially set the B MULTIPLIER and C MULTIPLIER switches to the 100 positions. GATE lamp should cycle on and off. If

TABLE 3-13. (Continued)

STEP	ACTION
	Note (cont)
	not, adjust B MULTIPLIER switch and B TRIGGER VOLTS control until lamp lights, and/or adjust C MULTIPLIER switch and C TRIGGER VOLTS control until lamp repeatedly goes off, and until repeated readouts are consistent. Determine the trigger points by the product of the MULTIPLIER and TRIGGER VOLTS settings.
16	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.
17	Numerical display is the number of cycles of the signal applied to the FREQ. A input connector that occur between the B and C input trigger points.

Note

Tables 3-14, 3-15, and 3-16 provide procedures for totalizing with manual reset required. Automatic reset can be accomplished with two methods by following the procedures in the tables with the following exception:

Method 1. Set DISPLAY control to the MIN. position, and set POWER switch to STORE. Reset will automatically take place when the FUNCTION switch is set to MAN. START.

Method 2. Set DISPLAY control to any position except ∞, and set POWER switch to TRACK. Reset will automatically take place at the end of the display time, or if a Printer is connected, at the end of printout.

TABLE 3-14. PROCEDURE FOR TOTALIZING, WITH THE INPUT SIGNAL APPLIED TO CHANNEL A

STEP	ACTION
1	Perform turn-on procedure described in table 3-3. Set POWER switch to TRACK or STORE.
2	Set SENSITIVITY switch to 100 V.
3	Set DISPLAY control to ∞.
4	Set time base switch to 10^8.
5	Set FUNCTION switch to MAN START, and note that GATE lamp goes on.
6.	Connect input signal to the FREQ. A input connector.
7	Press RESET switch and observe digital display. If display advances numerically from zero, proceed to step 9. If display remains at zero (evidence of weak input signal), proceed to step 8.

TABLE 3-14. (Continued)

STEP	ACTION
8	Turn SENSITIVITY switch counterclockwise, one position at a time; leave SENSIVITY switch in the first position at which display advances numerically from zero in accordance with the number of input pulses.
9	Press RESET switch. Totalizing starts automatically when RESET switch is released. Stop totalizing by setting FUNCTION switch to MAN STOP. Note that GATE lamp goes off and the accumulated count is displayed.
10	To start another totalizing measurement, first press RESET switch to erase the previous count, then set FUNCTION switch to MAN START. Results of two or more measurements may be added by not pressing the RESET switch.

TABLE 3-15. PROCEDURE FOR TOTALIZING, WITH THE INPUT SIGNAL APPLIED TO CHANNEL C

Note

Follow this procedure only when the input signal does not exceed 1 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3. Set POWER switch to TRACK or STORE.
2	Set SENSITIVITY switch to FREQ. C.
3	Set DISPLAY control to ∞.
4	Set time base switch to 10^8.
5	Set mode selector switch to SEP.
6	Set FUNCTION switch to MAN START, and note that GATE lamp goes on.
7	Set C MULTIPLIER switch to 100.
8	Set C TRIGGER VOLTS control to 0.
9	Connect input signal to the applicable input C connector.
10	Press RESET switch. Observe digital display. If display advances numerically in accordance with the number of input pulses, proceed to step 12. If display does not advance, proceed to step 11.
11	Turn C TRIGGER VOLTS control slowly in both directions, and, if necessary, change the setting of the C SLOPE switch, until display advances numerically in accordance with the number of input pulses. If display does not advance (evidence of weak input signal), turn C

TABLE 3-15. (Continued)

STEP	ACTION
11 (cont)	MULTIPLIER switch clockwise to the first position at which the advance occurs.
12	Press RESET switch. Totalizing starts automatically when RESET switch is released. Stop totalizing by setting FUNCTION switch to MAN STOP. Note that GATE lamp goes off and the accumulated count is displayed.
13	To start another totalizing measurement, first press RESET switch to erase the previous count, then set FUNCTION switch to MAN START. Results of two or more measurements may be added by not pressing the RESET switch.

TABLE 3-16. PROCEDURE FOR TOTALIZING, WITH THE INPUT SIGNAL APPLIED TO THE CONVERTER CHANNEL

Note

Follow this procedure only when the input frequency falls between 35 mc and 100 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3. Set POWER switch to TRACK or STORE.
2	Set SENSITIVITY switch to PLUG-IN.
3	Set DISPLAY control to ∞.
4	Set time base switch to 10^8.
5	Set FUNCTION switch to MAN START, and note that GATE lamp goes on.
6	Set both converter attenuator switches to the right (10 V MAX position).
7	Set DIRECT-HETERODYNE switch to DIRECT.
8	Connect input signal to the converter INPUT connector.
9	Observe LEVEL METER. If it reads in the green zone, proceed to step 12. Otherwise, proceed to step 10.
10	Set upper attenuator switch to the left (2.0 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 12. Otherwise, proceed to step 11.

TABLE 3-16. (Continued)

STEP	ACTION
11	Set lower attenuator switch to the left (0.3 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 12. If it does not read in green zone, input level is too low for a valid measurement.
12	Press RESET switch. Totalizing starts automatically when RESET switch is released. Stop totalizing by setting FUNCTION switch to MAN STOP. Note that GATE lamp goes off and the accumulated count is displayed.
13	To start another totalizing measurement, first press RESET switch to erase the previous count, then set FUNCTION switch to MAN START. Results of two or more measurements may be added by not pressing the RESET switch.

TABLE 3-17. PROCEDURE FOR HETERODYNE FREQUENCY MEASUREMENT (85 MC TO 500 MC) WHEN APPROXIMATE INPUT FREQUENCY IS KNOWN

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to PLUG-IN.
3	Set FUNCTION switch to FREQ.
4	Set time base switch to GATE TIME (SEC-1)–10^6.
5	Set DISPLAY control for desired display time.
6	Set both converter attenuator switches to the right (10 V MAX position).
7	Set DIRECT-HETERODYNE switch to HETERODYNE.
8	Connect input signal to the converter INPUT connector.
9	Set FREQUENCY TUNING–MC switch to any applicable position as indicated below:

TABLE 3-17. (Continued)

STEP	ACTION		
9 (cont)	IF INPUT FREQUENCY IN MC IS BETWEEN	SET FREQUENCY TUNING-MC SWITCH TO	UNKNOWN FREQUENCY IS MIXING FREQUENCY SELECTOR SWITCH POSITION IN MC
	85-95	100	- digital display
	95-145	150	- digital display
	105-155	100	+ digital display
	145-195	200	- digital display
	155-205	150	+ digital display
	195-245	250	- digital display
	205-255	200	+ digital display
	245-295	300	- digital display
	255-305	250	+ digital display
	295-345	350	- digital display
	305-355	300	+ digital display
	345-395	400	- digital display
	355-405	350	+ digital display
	395-445	450	- digital display
	405-455	400	+ digital display
	445-495	500	- digital display
	455-500	450	+ digital display
10	Observe LEVEL METER. If it reads in the green zone, proceed to step 14. Otherwise, proceed to step 11.		
11	Set upper attenuator switch to the left (2.0 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 14. Otherwise, proceed to step 12.		
12	Set lower attenuator switch to the left (0.3 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 14. If it reads in the red zone, proceed to step 13.		
13	Press RESET switch. Observe digital display. If readout is zero or erratic, input signal level is too low for a valid measurement. If display is a consistent number, test its validity by complementing, as described in paragraph 3-5e.		
14	Observe digital display. Determine unknown frequency as described in step 9.		
15	If display is to remain constant except when the measurement result changes, set POWER switch to STORE.		
16	To obtain increased resolution, turn time base switch counterclockwise (up to 1).		

TABLE 3-18. PROCEDURE FOR HETERODYNE FREQUENCY MEASUREMENT (85 MC TO 500 MC) WHEN APPROXIMATE INPUT FREQUENCY IS UNKNOWN

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to PLUG-IN.
3	Set FUNCTION switch to FREQ.
4	Set time base switch to GATE TIME (SEC^{-1})–10^6.
5	Set DISPLAY control for desired display time.
6	Set both converter attenuator switches to the right (10 V MAX position).
7	Set DIRECT-HETERODYNE switch to HETERODYNE.
8	Connect input signal to the converter INPUT connector.
9	Starting at 100, turn FREQUENCY TUNING–MC switch clockwise, one position at a time, and observe LEVEL METER in each position. If LEVEL METER reads in the green zone in at least one switch position, proceed to step 12. Otherwise, proceed to step 10.
10	Set upper attenuator switch to the left (2.0 V MAX position) and repeat the procedure of step 9. If LEVEL METER reads in the green zone in at least one switch position, proceed to step 12. Otherwise, proceed to step 11.
11	Set lower attenuator switch to the left (0.3 V MAX position) and repeat the procedure of step 9. If LEVEL METER reads in the green zone in at least one switch position, proceed to step 12. If LEVEL METER reads in the red zone in all switch positions and: a. Readouts are zero or erratic. Input signal level is too low for a valid measurement. b. Readouts are consistent in switch position 100 or in two or three switch positions. Test the validity of the measurement by complementing, as described in paragraph 3-5e.

TABLE 3-18. (Continued)

STEP	ACTION	
12	Observe digital display in each mixing frequency selector switch position where LEVEL METER reads in the green zone. Interpret readout as follows:	
	SWITCH POSITIONS AT WHICH LEVEL METER READS IN THE GREEN ZONE	UNKNOWN FREQUENCY IS
a.	100 only.	100 mc - digital display.
b.	100 and 150 only and	
	(1) display at 100 plus display at 150 equals 50 mc.	100 mc + digital display at 100.
	(2) display at 150 minus display at 100 equals 50 mc.	100 mc - digital display at 100.
c.	150 only.	150 mc - digital display.
d.	100 and 200 only.	100 mc + digital display at 100.
e.	100, 150, and 200 only.	100 mc + digital display at 100.
f.	Any three adjacent positions only.	Lowest position in mc + digital display at that position.
g.	450 only.	450 mc + digital display.
h.	More than three positions, of which three are adjacent.	The reading in the non-adjacent position is not valid. The readings in the three adjacent positions are valid, and are interpreted as in "f".
13	If display is desired to remain constant except when measurement result changes, set POWER switch to STORE.	
14	To obtain increased resolution, turn time base switch counterclockwise (up to 1).	

TABLE 3-19. PROCEDURE FOR OBTAINING STANDARD FREQUENCIES

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set FUNCTION switch to TIME B➡C, MAN START, MAN STOP, or PERIOD B x M-1.

TABLE 3-19. (Continued)

STEP	ACTION	
3	Set STD FREQ OUT switch to obtain the desired output frequency as follows:	
	STD FREQ OUT SWITCH POSITION	OUTPUT FREQUENCY
	10^{-1}	0.1 cps
	1	1 cps
	10	10 cps
	10^2	100 cps
	10^3	1 kc
	10^4	10 kc
	10^5	100 kc
	10^6	1 mc
	10^7	10 mc
4	Obtain standard frequencies at the rear-panel STD FREQ OR SCALE OUT connector across a 50-ohm load.	

TABLE 3-20. PROCEDURE FOR SCALING, WITH THE INPUT SIGNAL APPLIED TO CHANNEL A

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to 100 V.
3	Set FUNCTION switch to SCALE A.
4	Set time base switch for desired SCALER RATIO (10, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7). The position of the switch determines the factor by which the frequency of the input signal will be divided.
5	Connect signal to be scaled to the FREQ. A connector.
6	Press RESET switch, and observe digital display. If display remains at zero, turn SENSITIVITY switch to the first counter-clockwise position at which display changes from zero and the count advances at the frequency of the input signal.
7	Obtain scaled output signal at the rear-panel STD FREQ OR SCALE OUT connector.

TABLE 3-21. PROCEDURE FOR SCALING, WITH THE INPUT SIGNAL APPLIED TO CHANNEL C

Note

Follow this procedure only when the input signal frequency does not exceed 1 mc.

STEP	ACTION
1	Perform turn-on procedure procedure described in table 3-3.
2	Set SENSITIVITY switch to FREQ. C.
3	Set FUNCTION switch to SCALE A.
4	Set time base switch for desired SCALER RATIO (10, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7). The position of the switch determines the factor by which the frequency of the input signal will be divided.
5	Set C TRIGGER VOLTS CONTROL to 0.
6	Set C MULTIPLIER switch to 100.
7	Connect signal to be scaled to the applicable input C connector.
8	Press RESET switch.
9	Turn C TRIGGER VOLTS control slowly in both directions, and, if necessary, change setting of C SLOPE switch, until display advances numerically at the frequency of the input signal. If display does not advance (evidence of weak input signal), turn C MULTIPLIER switch to the first position at which readout advances numerically in a continuous cycle.
10	Obtain scaled output signal at the rear-panel STD FREQ OR SCALE OUT connector.

TABLE 3-22. PROCEDURE FOR SCALING, WITH THE INPUT SIGNAL APPLIED TO THE CONVERTER CHANNEL

Note

Follow this procedure only when the input signal frequency falls between 35 mc and 100 mc.

STEP	ACTION
1	Perform turn-on procedure described in table 3-3.
2	Set SENSITIVITY switch to PLUG-IN.
3	Set FUNCTION switch to SCALE A.

TABLE 3-22. (Continued)

STEP	ACTION
4	Set both converter attenuator switches to the right (10 V MAX position).
5	Set DIRECT-HETERODYNE switch to DIRECT.
6	Set time base switch for desired SCALER RATIO (10, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7). The position of the switch determines the factor by which the frequency of the input signal will be divided.
7	Connect signal to be scaled to the converter INPUT connector.
8	Observe LEVEL METER. If it reads in the green zone, proceed to step 11. Otherwise, proceed to step 9.
9	Set upper attenuator switch to the left (2.0 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 11. Otherwise, proceed to step 10.
10	Set lower attenuator switch to the left (0.3 V MAX position) and observe LEVEL METER. If it reads in the green zone, proceed to step 11. If it does not read in the green zone, input level is too low for a valid measurement.
11	Obtain scaled output signal at the rear-panel STD FREQ OR SCALE OUT connector.

TABLE 3-23. PROCEDURE FOR OBTAINING STANDARD 1-MC OUTPUT SIGNAL

STEP	ACTION
1	Set POWER switch to STBY, TRACK or STORE, and allow a 5-minute warm-up.
2	Obtain standard 1-mc output signal at the rear panel 1 MC OUT connector on the radio frequency oscillator.

TABLE 3-24. PROCEDURE FOR TURNING COUNTER OFF

STEP	ACTION
1	Remove all external connections from the counter.
2	If the counter is temporarily not in use, but it is necessary to leave it turned on for instant service, set POWER switch to STBY. Otherwise, press and hold PUSH button, and set POWER switch to OFF.

3-9. OPERATOR'S MAINTENANCE.

Maintenance by operating personnel is limited to cleaning the air filter and replacing fuses. The location of defective components within the instrument often requires technical skill and use of trouble-shooting techniques. In many cases a calibration adjustment is required when a component is replaced. Therefore, only a qualified technician should attempt trouble shooting within the instrument.

3-10. OPERATING CHECKS AND ADJUSTMENTS.

The test function of the counter serves to check the operation of the majority of the circuits within the instrument. The procedure in paragraph 3-4 should be used in performing this check. The indications shown in table 3-4 should appear on the readout as the time base switch is rotated. The instrument is malfunctioning if the indications in table 3-4 are not obtained.

Adjustments to the counter other than normal operating adjustments should not be made by the operator.

3-11. PREVENTIVE MAINTENANCE.

The air filter installed over the air intake on the rear panel prevents dust and dirt from entering the counter. The filter must be cleaned periodically so as not to restrict air flow into the instrument. For the cleaning procedure, see paragraph 5-2. The fan motor is lubricated for life and should not require any preventive maintenance.

3-12. EMERGENCY MAINTENANCE.

Emergency maintenance procedures are limited to replacing the power supply fuses. Both fuses are located on the interface panel behind the electronic frequency converter. Should fuse replacement become necessary, loosen the converter thumbscrew and pull the converter out of the counter. Replacement fuses are located in clips adjacent to the fuse holders on the counter bracket exposed by removal of the converter. Both fuses are identical 3-ampere plug-in types. Be sure to install a new spare fuse in the clip after the fuse is removed for replacement. See figure 5-36 for fuse location.

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NAVSHIPS 0969-028-4020

VOLUME 2

OPERATORS' MANUAL

for

DIGITAL READOUT ELECTRONIC COUNTER

AN/USM-207

All replacement pages for this Volume 2 that are referenced in TEMPORARY CHANGES T-1, T-2, T-3, and T-4 (included with NAVSHIPS 0969-028-4010, Volume 1, Technical Manual for Digital Readout Electronic Counter AN/USM-207) have been bound into this Volume 2. Only the pen and ink changes listed in those temporary changes need be incorporated by the user.